Electromagnetic Modeling Capability
For MCM and Undersea Sensor Systems

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LONG-TERM GOAL

The long-term goal is to develop low frequency electromagnetic models and apply these models to improve the Navy's mine warfare programs.

OBJECTIVE

The objective is to collaborate with Woods Hole (Rob Evans) and develop EM tools that will improve the Navy's mine warfare programs. We will improve the Navy's EM forward modeling and data interpretation capability in a cost effective manner using academic resources and leveraging industry and other agency development efforts. These research efforts support the Organic Mine Countermeasures (MCM) and Littoral ASW Future Naval Capabilities (FNC) for both ONR and NRL projects with innovative EM numerical tools.

APPROACH

Participate in the University of Utah Consortium for Electromagnetic Modeling and Inversion (CEMI) under the direction of Dr. Zhdanov. Selected data from Woods Hole EM surveys will be used to develop innovative data inversion techniques. The software will become part of a Navy low frequency EM modeling capability that NRL has developed. NRL will manage the project and link Navy relevance for ONR research to the Organic Mine Countermeasures and Littoral ASW FNCs. As a member of the University of Utah consortium, NRL provides input to direct consortium research of model development in directions that are beneficial to the Navy.

The consortium supports a number of graduate students and research projects with the proceeds from consortium membership to develop the EM models. As a result, the modeling tools are only distributed to consortium members. To support other ONR researchers with this capability, NRL will also serve as the coordinator with these researchers so that they can take advantage of the CEMI modeling tools for their data interpretation.

WORK COMPLETED

The University of Utah consortium meets annually to review the progress and developments of the previous year. During the previous year a group of nine graduate students and four professors

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The long-term goal is to develop low frequency electromagnetic models and apply these models to improve the Navy???s mine warfare programs.

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produced thirteen papers detailing the results of new methods in EM model development. New model developments have included:

- Analysis and development of innovative 3-D EM forward modeling capability

- 3-D induced polarization and time domain EM inversion using a quasi-linear approximation technique

- Fast imaging and inversion of frequency and time domain EM observations

NRL has utilized EM forward modeling techniques to quantify the impact of STRATAFORM research on MCM sweeper systems in support of the Organic Mine Countermeasures (MCM) FNC. One paper has been accepted for publication in US Navy Journal of Underwater Acoustics (JUA) on the impact of anomalous bottom electrical properties for undersea surveillance systems. A second paper describing the impact of this research for MCM mine sweeping operations has been submitted to JUA for publication.

RESULTS

NRL has determined that anomalous bottom electrical properties like those discovered in the STRATAFORM area off the coast of California can have a very significant impact on MCM sweeping systems. Suggested causes for the anomalous properties (Evans et al., 1999) could occur on most areas of the continental shelf. As a result, this type of geologic feature poses a large risk for organic MCM sweeping operations where environmental data are not available.

IMPACT/APPLICATION

This work emphasizes the importance for ONR and NRL research to identify environmental variability prior to use of future organic MCM systems like OASIS. OASIS is an organic MCM system currently under development at the Coastal Systems Station, Panama City, FL.

TRANSITIONS

Models from this work have been transitioned to the NRL Multiple-Influence Detection task and used by NRL to evaluate MCM sweeper parameters in coastal areas.

RELATED PROJECTS

Two related projects have contributed to the understanding of the geology associated with seafloor electrical properties. These are the ONR funded work by Rob Evans and Dan Lizarralde “Assessment of Electrical Resistivity Anomalies Caused by Fresh Water Discharge Offshore: Analysis of Data Collected off North Carolina and California” and the ONR funded work by Rob Evans “An EM Survey Around the Martha’s Vineyard Observatory”. These research projects are developing valuable relationships for the electrical properties of the seafloor. Both the data and the conclusions are being used in the NRL work to evaluate the impact on MCM operations.

REFERENCES

R. L. Evans, L. K. Law, B. St. Louis, S. Cheesman, and K. Sananikone, "The shallow porosity structure of the continental shelf off Humboldt Bay, California: Results of a towed electromagnetic survey," Marine Geology, Vol. 154, pp. 211-226, 1999.

PUBLICATIONS

Avera, W. and Wayne Kinney, Effects of an Inhomogeneous Electrically Resistive Bottom on Nonacoustic Detection (U), Accepted for publication in Journal of Underwater Acoustics (JUA) Winter 2002 issue.

Avera, W. and Edward Mozley, Bathymetry and Bottom Electrical Properties from an Airborne Electromagnetic Survey at Kings Bay, Georgia, MARELEC Conference, Stockholm Sweden, 11-13 July 2001.